Formative Assessments of the Framework using NAEP

2017 OPI Assessment and Data Conference
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Hilton Garden Inn, Missoula

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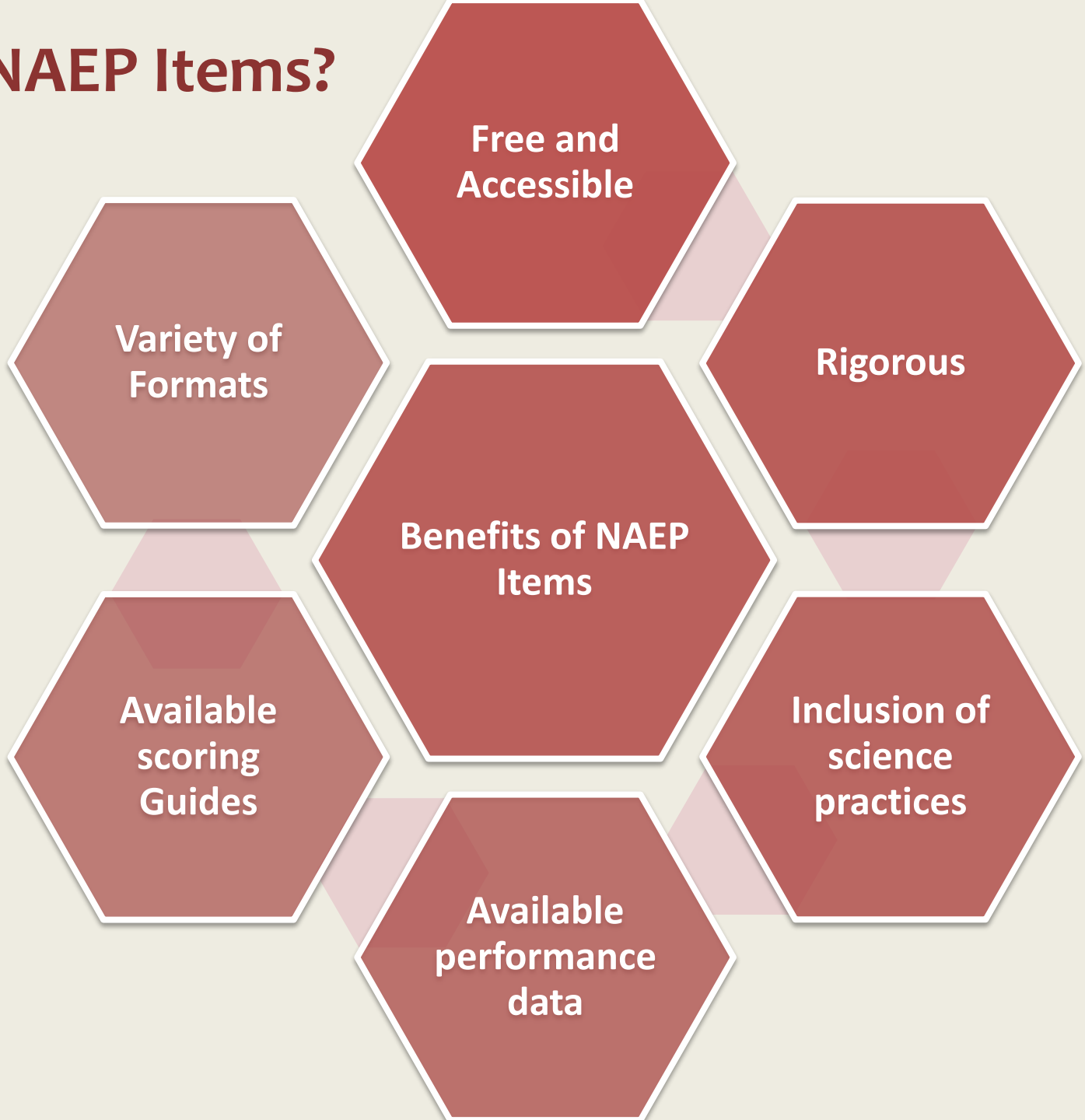
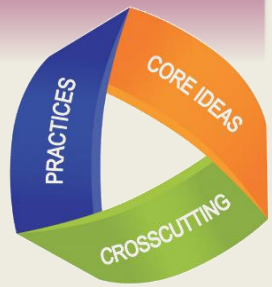
Why NAEP Items?



Meeting the Targets

- NAEP items include the 3-dimensions
  - Not always in the way the NGSS PEs call for
  - Sometimes almost identical



Two farmers notice that some bean plants are much taller than others, even though they are growing in the same field. One farmer thinks the difference in height is due to inheritance. The other farmer thinks it is because some plants in the field get more water than others.

Describe an experiment that will provide evidence for which farmer is right. You can use seeds from both tall and short plants.

Describe the steps you will follow.

_____

_____

_____

Describe how you will collect your data.

_____

_____

How will you conclude if tallness is inherited or caused by getting more water?

_____

_____

_____

Science Standards Grade by Grade (2016) (here)

2012:
Publication of *A Framework for K – 12 Science Education*

2013:
Publication of Next Generation Science Standards

2014:
NRC Report Published on Assessments for NGSS identifies NAEP as a potential exemplar

2016:
16 States have adopted NGSS

15 States have adopted Framework-Based Standards

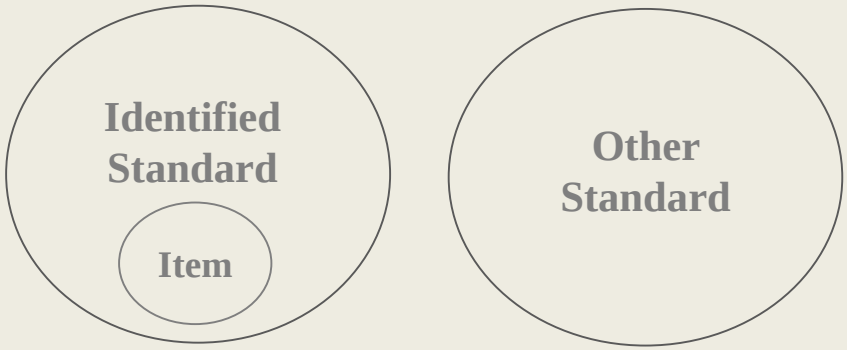
Montana adopts aligned standards September 2016

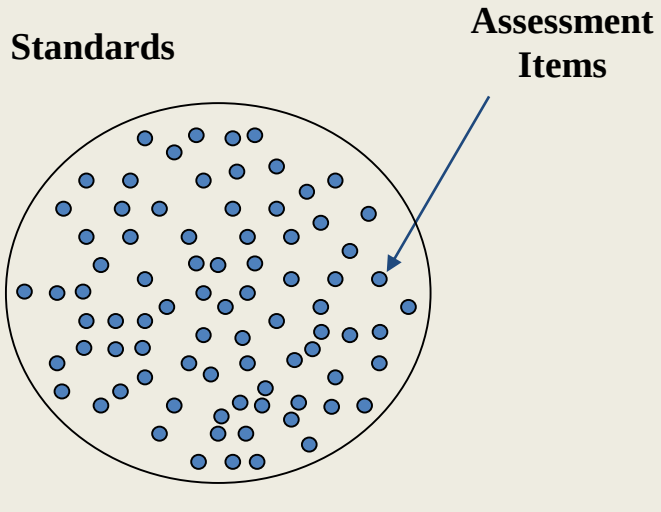
*Slide current as of 10/23/2016

Criterion for Item Sets

- Strong alignment
  - Rated a 3 for DCI and 3 for grade band
- NGSS Topic arrangement used to build cohesive sets.

3 **Excellent**: this question clearly belongs in this category, we have no reservations about this





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Item Sets

- Structure of Item Set Packets:
  - Storyline from NGSS Topic Arrangement
  - NGSS Topic Arrangement Page
  - Evidence Statements for Individual Performance Expectations
  - Items

(Repeats from NGSS Topic Arrangement Page for each topic in MS/HS and from the storyline page for each grade in Elem)

Item Set Structure

PDF Storyline from NGSS Topic Arrangement.

Performance Expectations

NEXT GENERATION SCIENCE STANDARDS

Middle School Life Science

Students in middle school develop understanding of key concepts to help them make sense of life science. The ideas build upon students' science understanding from earlier grades and from the disciplinary core ideas, science and engineering practices, and crosscutting concepts of other experiences with physical and earth sciences. There are four life science disciplinary core ideas in middle school: *1) From Molecules to Organisms: Structures and Processes, 2) Ecosystems: Interactions, Energy, and Dynamics, 3) Heredity: Inheritance and Variation of Traits, 4) Biological Evolution: Unity and Diversity.* The performance expectations in middle school blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge across the science disciplines. While the performance expectations in middle school life science couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many science and engineering practices integrated in the performance expectations.

The performance expectations in **LS1: *From Molecules to Organisms: Structures and Processes*** help students formulate an answer to the question, "How can one explain the ways cells contribute to the function of living organisms." The LS1 Disciplinary Core Idea from the *NRC Framework* is organized into four sub-ideas: Structure and Function, Growth and Development of Organisms, Organization for Matter and Energy Flow in Organisms, and Information Processing. Students can gather information and use this information to support explanations of the structure and function relationship of cells. They can communicate understanding of cell theory. They have a basic understanding of the role of cells in body systems and how those systems work to support the life functions of the organism. The understanding of cells provides a context for the plant process of photosynthesis and the movement of matter and energy needed for the cell. Students can construct an explanation for how environmental and genetic factors affect growth of organisms. They can connect this to the role of animal behaviors in reproduction of animals as well as the dependence of some plants on animal behaviors for their reproduction. Crosscutting concepts of cause and effect, structure and function, and matter and energy are called out as organizing concepts for the core ideas about processes of living organisms.

The performance expectations in **LS2: *Interactions, Energy, and Dynamics Relationships in Ecosystems*** help students formulate an answer to the question, "How does a system of living and non-living things operate to meet the needs of the organisms in an ecosystem?" The LS2 Disciplinary Core Idea is divided into three sub-ideas: Interdependent Relationships in Ecosystems; Cycles of Matter and Energy Transfer in Ecosystems; and Ecosystem Dynamics, Functioning, and Resilience. Students can analyze and interpret data, develop models, and construct arguments and demonstrate a deeper understanding of resources and the cycling of matter and the flow of energy in ecosystems. They can also study patterns of the interactions among organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on population. They evaluate competing design solutions for maintaining biodiversity and ecosystem services.

The performance expectations in **LS3: Heredity: Inheritance and Variation of Traits** help students formulate an answer to the question, "How do living organisms pass traits from one generation to the next?" The LS3 Disciplinary Core Idea from the *NRC Framework* includes two sub-ideas: Inheritance of Traits, and Variation of Traits. Students can use models to describe

MS.Matter and Energy in Organisms and Ecosystems

MS.Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

MS-LS1-6. **Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.** [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]

MS-LS1-7. **Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.** [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]

MS-LS2-1. **Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

MS-LS2-3. **Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.** [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

MS-LS2-4. **Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.** [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to describe phenomena. (MS-LS2-3)
- Develop a model to describe unobservable mechanisms. (MS-LS1-7)

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-6)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).
- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence
- Science knowledge is based upon logical connections between evidence and explanations. (MS-LS1-6)
- Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

Disciplinary Core Ideas

LS1.C: Organization for Matter and Energy Flow in Organisms
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

LS2.A: Interdependent Relationships in Ecosystems
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

PS3.D: Energy in Chemical Processes and Everyday Life
- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. *(secondary to MS-LS1-6)*
- Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. *(secondary to MS-LS1-7)*

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

Energy and Matter
- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Stability and Change
- Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)

Connections to other DCIs in this grade-band: **MS.PS1.B** (MS-LS1-6),(MS-LS1-7),(MS-LS2-3); **MS.LS4.C** (MS-LS2-4); **MS.LS4.D** (MS-LS2-4); **MS.ESS2.A** (MS-LS1-6),(MS-LS2-3),(MS-LS2-4); **MS.ESS3.A** (MS-LS2-1),(MS-LS2-4); **MS.ESS3.C** (MS-LS2-1),(MS-LS2-4)

Articulation across grade-bands: **3.LS2.C** (MS-LS2-1),(MS-LS2-4); **3.LS4.D** (MS-LS2-1),(MS-LS2-4); **5.PS3.D** (MS-LS1-6),(MS-LS1-7); **5.LS1.C** (MS-LS1-6),(MS-LS1-7); **5.LS2.A** (MS-LS1-6),(MS-LS2-1),(MS-LS2-3); **5.LS2.B** (MS-LS1-6),(MS-LS1-7),(MS-LS2-3); **HS.PS1.B** (MS-LS1-6),(MS-LS1-7); **HS.PS3.B** (MS-LS2-3); **HS.LS1.C** (MS-LS1-6),(MS-LS1-7),(MS-LS2-

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.

Item Set Structure

NGSS PE Evidence Statements [click here]

[NGSS Aligned NAEP Science Items]

NEXT GENERATION SCIENCE STANDARDS For States, By States

"Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.

MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

MS-LS2-1. **Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena.	**LS2.A: Interdependent Relationships in Ecosystems** • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. • Growth of organisms and population increases are limited by access to resources.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Observable features of the student performance by the end of the course:

1	Organizing data	
	a	Students organize the given data (e.g., using tables, graphs, and charts) to allow for analysis and interpretation of relationships between resource availability and organisms in an ecosystem, including:
		i. Populations (e.g., sizes, reproduction rates, growth information) of organisms as a function of resource availability.
		ii. Growth of individual organisms as a function of resource availability.
2	Identifying relationships	
	a	Students analyze the organized data to determine the relationships between the size of a population, the growth and survival of individual organisms, and resource availability.
	b	Students determine whether the relationships provide evidence of a causal link between these factors.
3	Interpreting data	
	a	Students analyze and interpret the organized data to make predictions based on evidence of causal relationships between resource availability, organisms, and organism populations. Students make relevant predictions, including:
		i. Changes in the amount and availability of a given resource (e.g., less food) may result in changes in the population of an organism (e.g., less food results in fewer organisms).
		ii. Changes in the amount or availability of a resource (e.g., more food) may result in changes in the growth of individual organisms (e.g., more food results in faster growth).
		iii. Resource availability drives competition among organisms, both within a population as well as between populations.
		iv. Resource availability may have effects on a population's rate of reproduction.

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Formative Item Set Middle School

NAEP Specifications:

Item Reference:	200912105-S	**Item Type:**	ECR
Available online:	No	**Estimated Time Needed:**	1
Grade:	12	**Year:**	2009
Nation's %	28%	**Subtopic:**	Life Science
Item Description:	Relate patterns in data to cellular processes		
Science Practices (2009 and on)	Using Scientific Inquiry	**Item Difficulty:**	Hard
Knowing and Doing Science (1996-2005)		**Duplicate Status:**	
NQT Bookmark	http://nces.ed.gov/NationsReportCard/nqt/link/ItemList/224409		
Follow Website Link:	http://nces.ed.gov/nationsreportcard/itmrlsx/portal.aspx?type=display&questionlist=2009-12510-S&index=1&tab=ques		

Item:

Classifications:

	Fit	Code	Evidence/Comments
Component DCI	3	LS2.A	pg 152 Growth of organisms and population increases are limited by access to resources..
Grade-Band (K-2, 3-5, 6-8, 9-12)	3	3	
NGSS Topic Arrange-ment	3	MS.Matter and Energy in Organisms and Ecosystems	
NGSS PE	—	MS-LS2-1	Great applied item.

Note: The following codes were used for grade-band (i.e., K-2 = 1; 3-5 = 2, 6-8 = 3; and 9-12 = 4)

Montana Office of Public Instruction

Questions? Contact Ashley McGrath at amcgrath@mt.gov

High Quality

The Next Generation Science Standards

Performance Expectations

Knowledge, Skills & Abilities

Evidence to be Elicited from Student

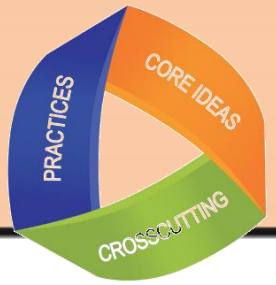
Methods for Eliciting Evidence

Items

Performance Expectations

Foundation Boxes

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts



Connections to

- Other science disciplines at this grade level
- Other DCIs for older and younger students
- Common Core State Standards in Mathematics and Language Arts

Eliciting Evidence

- What evidence is required given the assessment target I am measuring?
- What are the key features that must be included in the item?
- Will this item allow for the production of the evidence I am seeking?
- Is there anything about this item that may make it more difficult to collect evidence from students?

Source: Smarter Balanced Assessment Consortium. Using Evidence-Centered Design to Guide Item Design.

Item Features

Click here to access item.

If all of the small fish in the pond system died one year from a disease that killed only the small fish, what would happen to the algae in the pond?

Explain why you think so.

What would happen to the large fish? Explain why you think so.

Student provides a response that demonstrates a grasp of the interrelationships of the system by stating both predictions, and explanations.

- Student provides an explanation for the algae is that it is not eaten because the small fish died out
- large fish starve because their food source (small fish) is gone.

A Framework for K-12 Science Education:

By the end of grade 8. Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all of its populations. Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

[**Clarification Statement:** Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

Item Features

- **Observable features of the student performance by the end of the course:**
  - **Supported claims**
    - Students make a supported claim for their explanation. In their claim, students include the idea that changes to physical or biological components of an ecosystem can affect the populations living there.
  - **Identifying scientific evidence**
    - Students identify and describe the evidence needed to support the claim, including:
      - Evidence of causal and correlational relationships between changes in the components of an ecosystem with the changes in populations.
  - **Evaluating and critiquing the evidence**
    - Students identify the necessary and sufficient evidence for supporting the claim.
  - **Reasoning and synthesis**
    - Students use reasoning to connect the appropriate evidence to the claim and construct an oral or written argument about the causal relationship between physical and biological components of an ecosystem and changes in organism populations, based on patterns in the evidence. Argument describes a chain of reasoning such as:
      - Specific changes in the physical or biological components of an ecosystem cause changes that can affect the survival and reproductive likelihood of organisms within that ecosystem (e.g., scarcity of food or the elimination of a predator will alter the survival and reproductive probability of some organisms).

NGSS Evidence Statement

Purpose of Assessment

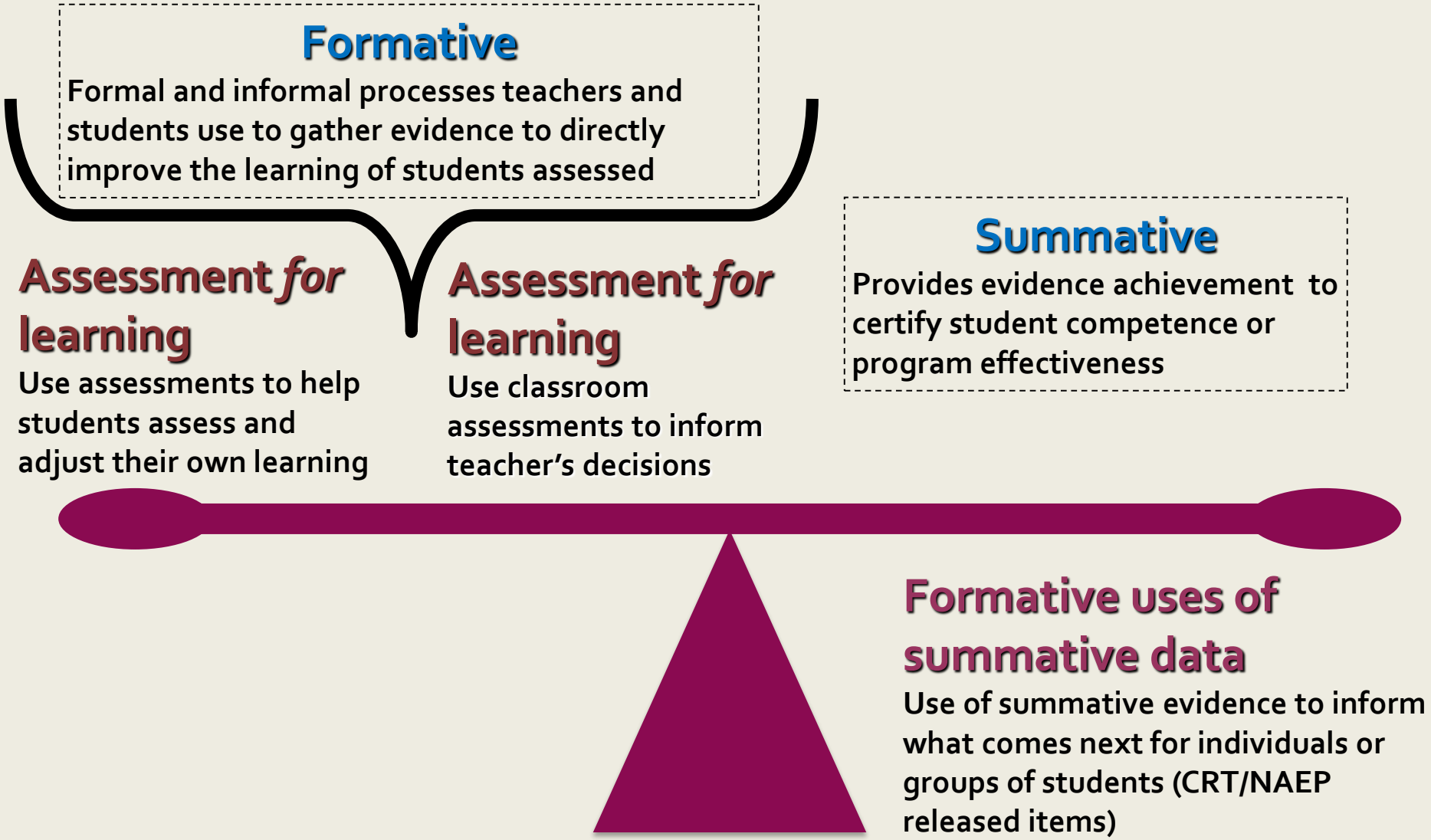
Assessment driven instruction is instruction that is guided by, and responsive to, information (data) we have about our students. It will include both Summative and Formative assessment

SUMMATIVE

- Assessments *OF* Learning
  - How much have students learned as of a particular point in time? **(After the learning has taken place)**

FORMATIVE

- Assessments *FOR* Learning
  - How can we use assessment information to help students learn more? **(During the learning)**

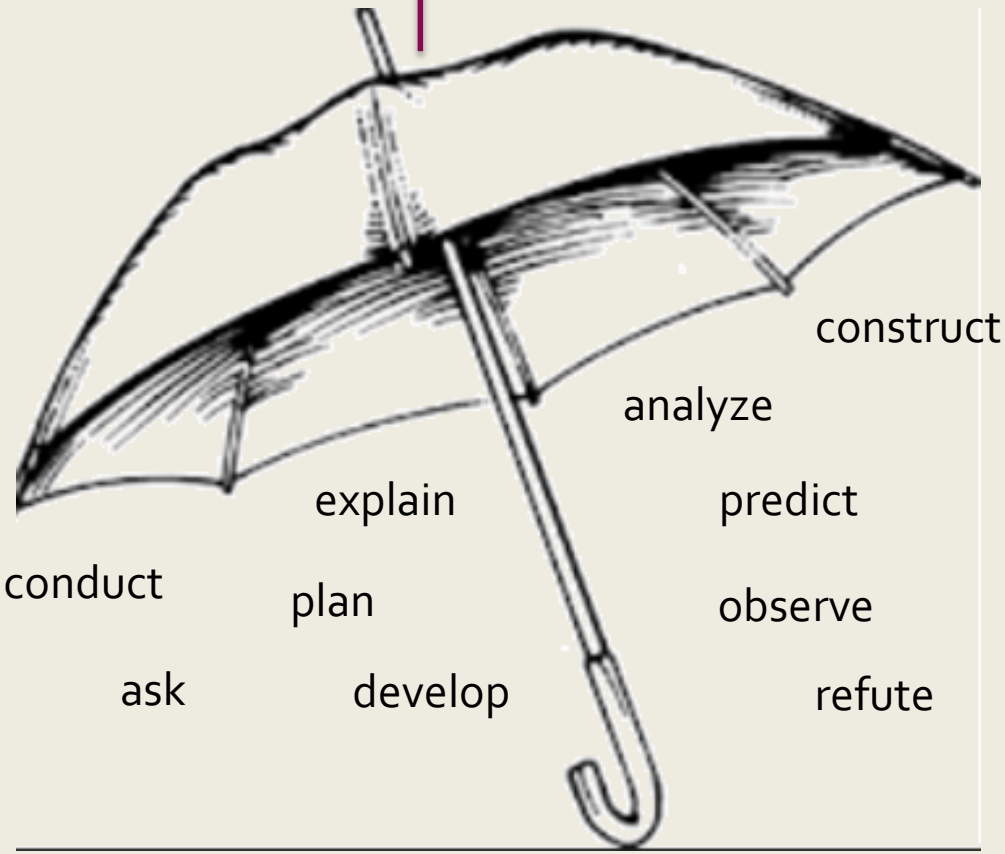


Balanced Assessment

How do you know?

What do these students **know**?

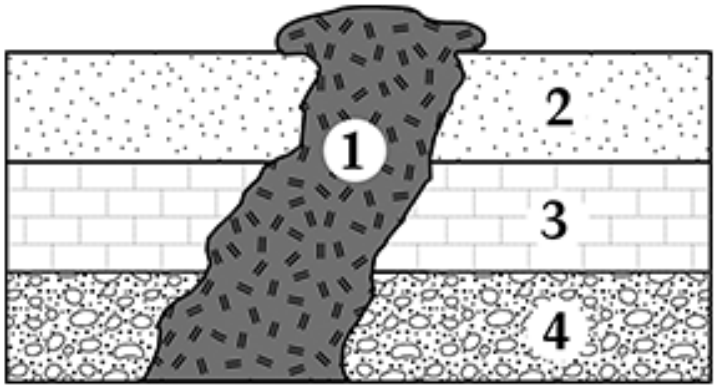
What can these students **do**?



For Example

- **MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.**

The diagram below shows a cross section of rock formations.



Which rock formation was formed most recently?

A. 1
B. 2
C. 3
D. 4

Explain why you chose your answer and not the others.

For Example

An unusual type of fossil clam is found in rock layers high in the Swiss Alps. The same type of fossil clam is also found in the Rocky Mountains of North America. From this, scientists conclude that

A. glaciers carried the fossils up the mountains

B. the Rocky Mountains and the Swiss Alps are both volcanic in origin

C. clams once lived in mountains, but have since evolved into sea-dwelling creatures

D. the layers of rocks in which the fossils were found are from the same geologic age

A newspaper article reported that a fossil was found that was 200,000 years old according to generally accepted radioactive dating procedures. A letter to the editor of the newspaper disputed the accuracy of the age determination because the fossil was found closer to the Earth's surface than were previously discovered fossils of the same age.

Which of the following would be an appropriate argument against the letter writer's claim?

A. Older rock layers commonly lie deeper underground than younger ones.

B. Older rock layers may be pushed closer to the surface by geologic processes.

C. The age of a rock layer can often help in determining the age of the fossils it contains.

D. Fossils form only under certain conditions.

Item Considerations

1. The **stem** is the initial part of the item in which the task is defined.

A. The **options** refer to the entire set of labeled response choices presented under the stem. (2)

B. Options

C. Options

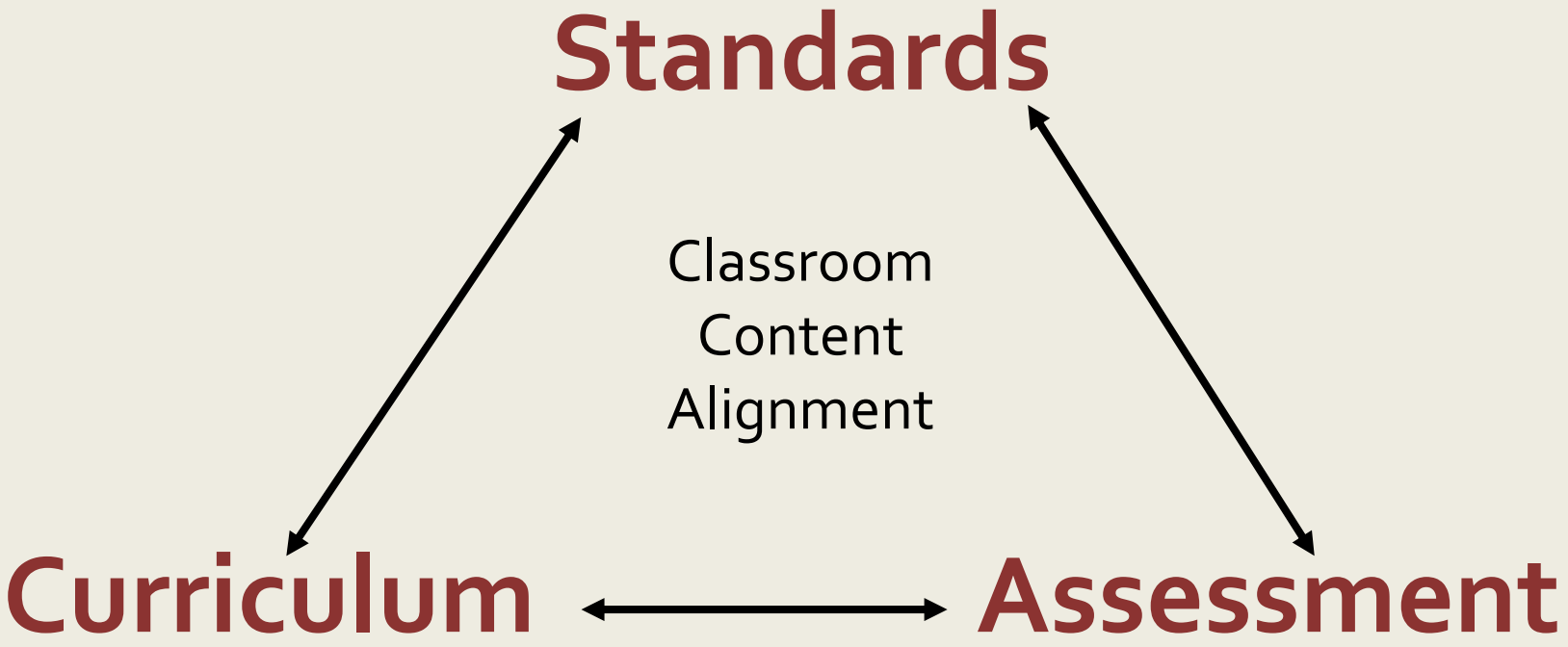
D. Options

E. Options

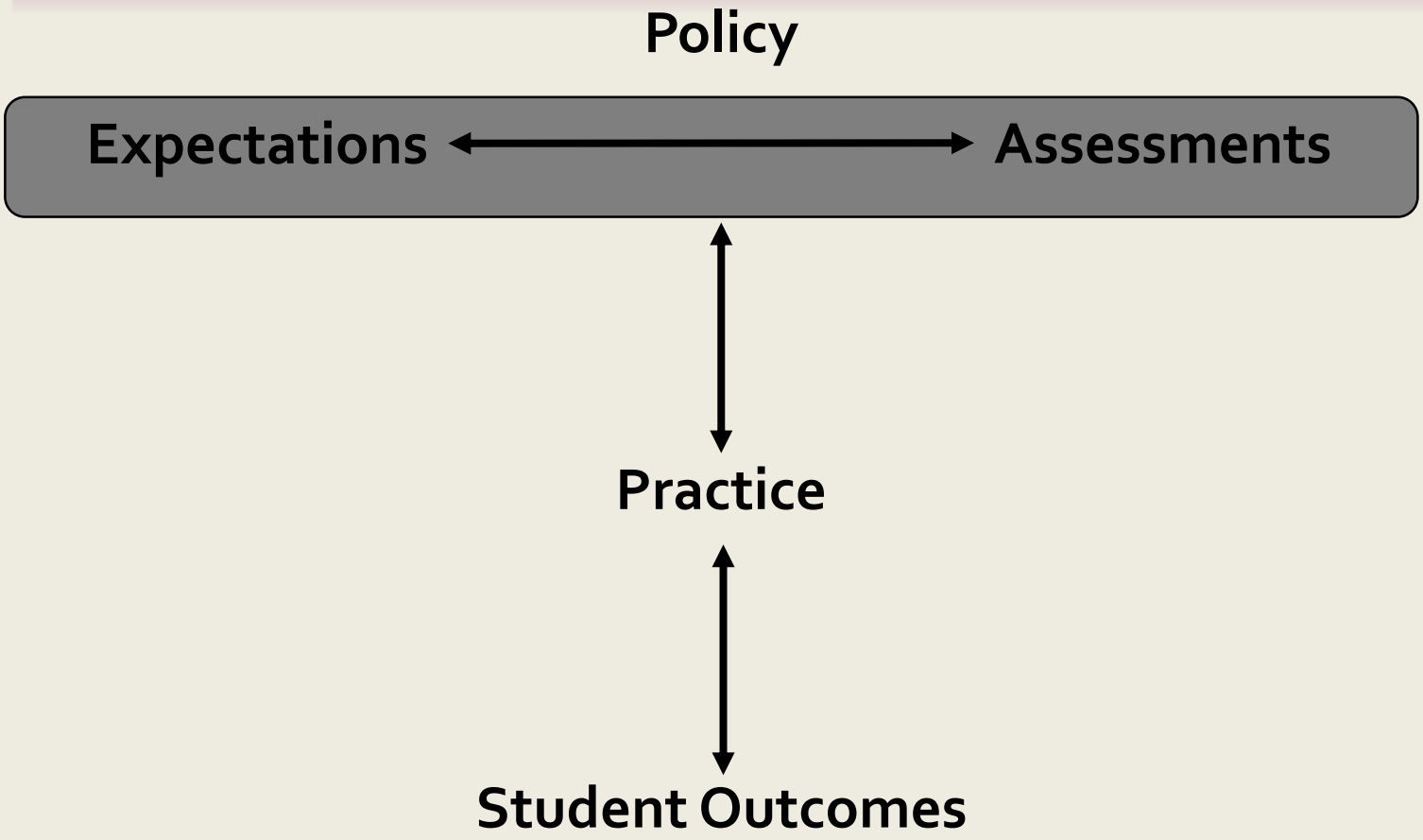
3. The **key** is the correct response option.

4. The **distracters** are the incorrect response options.

Alignment


Standards
Classroom
Content
Alignment
Curriculum
Assessment

Vertical and Horizontal Alignment



http://wat.wceruw.org/index.aspx

Evidence of Standard?

2. Which layer of Earth is divided into plates?

A. Mantle

B. Crust

C. Inner core

D. Outer core

Application

- **Assess prior knowledge**
  - Content
  - Skills
- **Assess application skills**
  - Content
  - Skills

Formative Classroom Assessment Techniques

- Kahoot pre/post tests
- Student-generated test questions
- KWL /KWHLAQ
- Minute paper
- Muddiest point
- One sentence summary
- Analogies

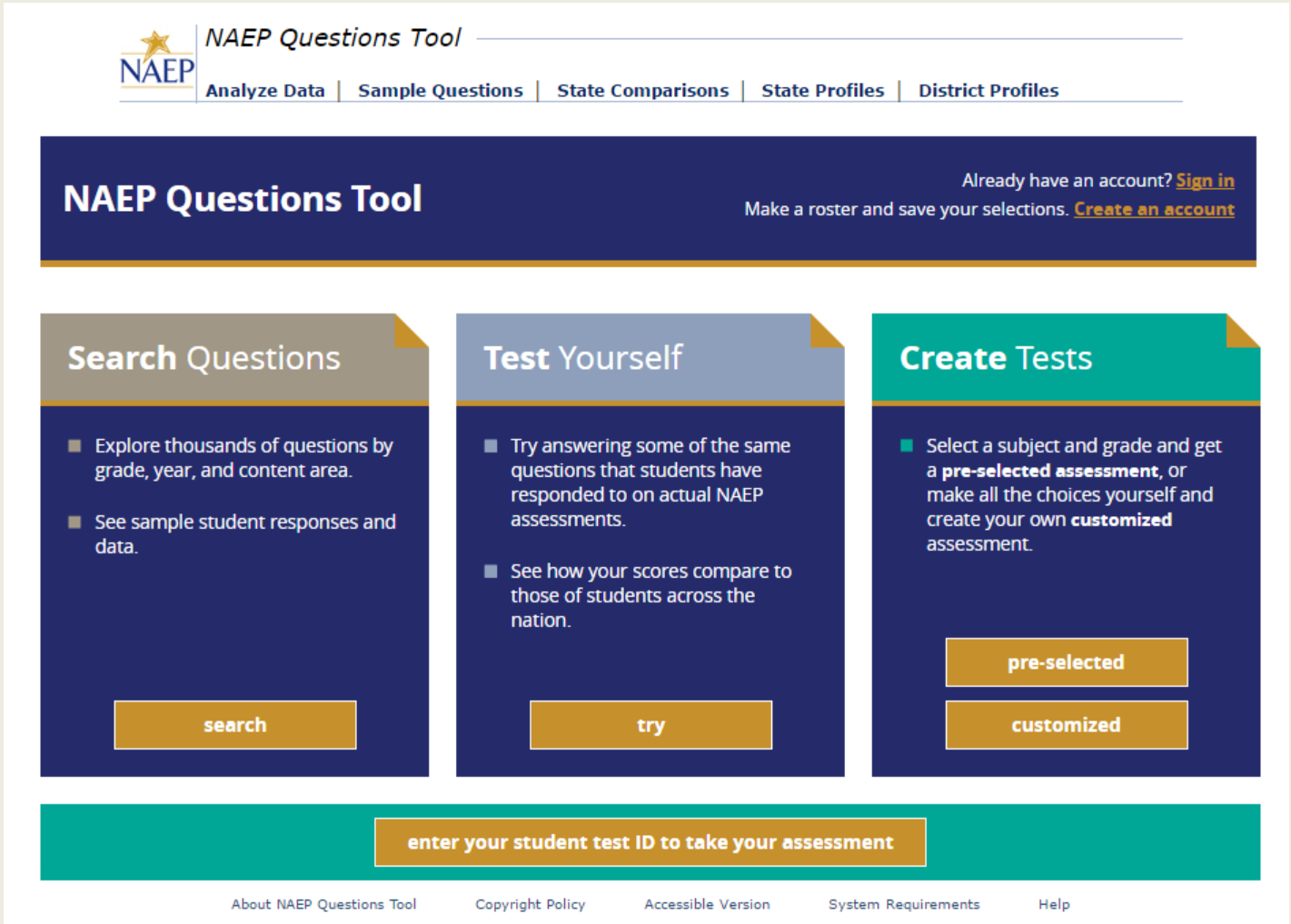
Angelo, T. and Cross. P (1993). Classroom Assessment Techniques: A Handbook for College Teachers. Second edition.

Application

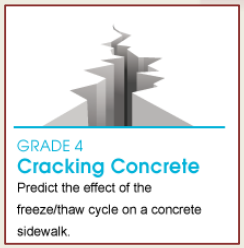
- Considering the student knowledge needed in these standards and items, what implications to classroom practices emerge?
- Are your assessments and classroom activities grade-level appropriate and rigorous in nature as the *Framework* calls for?
- Which skills do you elevate for these different topic arrangements?
- What language would make it into your assessment tools?
- How might a focus on concepts versus topics inform your instruction?

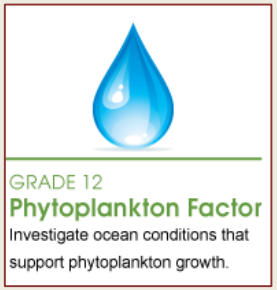
Access the NQT

- http://nces.ed.gov/nationsreportcard/nqt



Access SBTs





Explore 9 Interactive Computer Tasks

Explore 4 Technology and Engineering Literacy Scenario Based Tasks (SBTs):

- Develop an Online Exhibit about Chicago's Water Pollution Problem in the 1800s
- Design a Safe Bike Lane
- Create an Ideal Iguana Habitat
- Create Content for a Website Promoting a Teen Recreation Center

Questions?

Ashley McGrath
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Location of Materials:
https://sites.google.com/a/opiconnect.org/montananaep/resources/